Business WHITE PAPER

BREIN

BUSINESS OBJECTIVE DRIVEN RELIABLE AND INTELLIGENT GRIDS FOR REAL BUSINESS

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EXECUTIVE SUMMARY

The Grid adoption inside business environments has not experienced the same uptake as anticipated with respect to the experience in science and academic institutions. Nowadays, they are some examples of Grid implementations for some industrial sectors such as aerospace, automotive or pharmaceuticals, but they involves only single companies which own their infrastructure and high technical and economical resources. Thus, SMEs, which cannot afford high investments, are out of these businesses, and new requirements for developing complex business services by enterprises collaborations are not considered.

Thus, BREIN arises in order to address these problems by the introduction of Software as a Service model and by supporting collaborations among enterprises in a dynamic and flexible way. The BREIN project aims to develop a framework, which will extend the Grid possibilities by driving their usage inside new target areas in the business domain. In this matter, BREIN is dealing with providing all necessary basics these new business models need: enterprises' system interoperability, flexible relationships, dynamicity in business processes, security mechanisms and enhanced SLA and contract Management.

NEW BUSINESS MODELS

The introduction of Information and Communication Technology (ICT) and Internet inside the business is changing the way that enterprises are doing their work, creating new opportunities for the society of information provides. Concretely, using the Web infrastructure, extranets connect enterprises to their channel partners and the Internet links the enterprises to their customers, other institutions and agencies. In addition, customers are demanding more complex and integrated services (from third parties), tailored to their specific needs.

Moreover, outsourcing is becoming increasingly popular since companies can outsource some work to third-party more expert enterprises. Outsourcing provides an

efficient and cost effective infrastructure that is far cheaper and offers far better economies of scale than the customer's own processes, as it lets each party in the relationship concentrate on their core business. In this matter, each enterprise specializes in concrete tasks and its business model should take into account the different enterprises making up the value chain.

All these changes are supposing a constant readjustment of business models, which is viewed by companies like an opportunity that they try to take advantage, integrating their business, selling products of third companies that supplement their offer, and incorporating technologies that facilitate agility and flexibility to changes.

However, as the supply chain of business model is more and more complicated, the complexity of business relationships is increased. Indeed, this complexity can exclude SMEs from these models, since they can not afford the infrastructure investment in software and hardware and do not have technical resources to deal with the installation and maintenance of this infrastructure.

In order to solve these problems, new payment models have arisen like pay-per-use, which can be used in models such as "Software as a Service" (SaaS) and customer's access and use these services over the Internet.

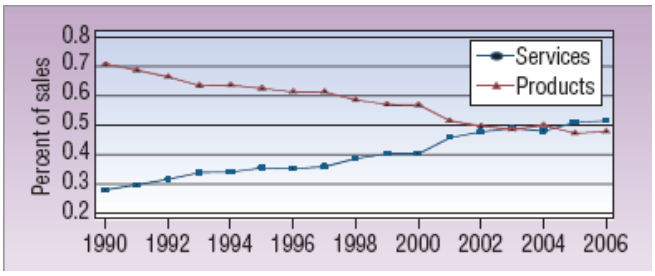


Figure. 1. Industry crisscross. Software product firms overall saw product revenues decline from 70 percent in 1990 to less than 50 percent in 2003.

This situation implies that software providers require new computing capacity to be offered on demand. On one hand, the provider could buy those machines required, but due to the variable nature of computing demands, the capacity requirements are difficult to plan for, creating the risks of under-provisioning or the wasting of resources. On the other hand, it could use computing capacity offered by providers of computing services. In this matter, Service Providers can outsource computing to other Service Providers, acting as customer for this bipartite relationship. In addition, SMEs can move away from their limited area of business (interests) and offer adapted services to interested customers, which gives them a more diverse, stable and stronger business opportunities and with that to compete on the market.

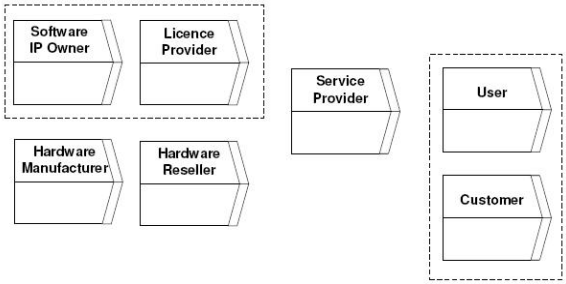


Figure. 2. shows the value system illustrating the new business models discussed above. Mainly, it involves providers of resources (machines, hardware), service providers (computing and software), and finally the customer, who is able to use these services.

Attracted by the potential for B2B relationships among companies to bundle more elaborate and profitable services, entrants to the service market are increasing. As new enterprises are continually joining the service market place, business value systems are being more and more complex. This creates new requirements such as: i) enterprises interoperability to solve the heterogeneity problems due to different information exchanged among enterprises, ii) relationships management considering SLA management, accounting, billing..., iii) task automation to reduce time and effort, iv) dynamic enterprise relationships and business processes, to achieve flexibility, dynamic and agility in execution and v) security mechanism to assure enterprise data privacy, authentication, authorization and trust.

Addressing these requirements will assist an SME enormously to get involved with these new business models by permitting them to use service-based infrastructures with low entry costs.

Technological solutions

Technically, a Service Oriented Architecture permits dealing with the outsourcing of work as services. It promotes the idea of assembling application

components into a network of services that can be loosely coupled to create flexible, dynamic business processes and agile applications that span organizations and computing platforms. The use of SOA is an evolution from the traditional architectures of applications or maps of systems that we find in the departments of information systems, toward an architecture of processes and services that increase companies' flexibility, so they can better address changes of business (fusions of companies, temporary alliances among companies to attack determined markets, regulatory aspects of each country, internal reorganizations in one company,...).

Moreover, Grid technologies provide mechanisms for sharing and coordinating the use of diverse resources and thus enable the creation, from geographically and organizationally distributed components, of virtual computing systems that are sufficiently integrated to deliver desired qualities of service. In this model, a service provider hosts and manages the Grid solution dedicated for serving customers.

To sum up, with the growing demand for fast, reliable and electronic business provisioning, the according middleware needs to hide complexity from the users that don't need to see it whilst retaining full control from both the provider and consumer sides of a business relationship. This is one of the main objectives of BREIN, and BREIN intends to address this by providing tools that permit different business actors to do what they are good at. For example we want to let engineers use fluid dynamics codes (their field of expertise), and let their managers control the business side. This means that each actor is operating within a field they know and understand, and can collaborate to increase efficiency and thereby wealth.

BREIN: BUSINESS OBJECTIVE DRIVEN RELIABLE AND INTELLIGENT GRIDS FOR REAL BUSINESS

The research Project BREIN, partially funded by the EC under the FP6, has as its main objective the creation of an infrastructure that will support collaboration among companies in a dynamic and changing environment. The project has a strong focus on business requirements established by the definition of two scenarios (Virtual Engineering and Airport Resource Management) driven by two main end-user stakeholders in the project: ANSYS Europe Ltd and Stuttgart Airport.

BREIN aims to develop a framework that will extend the possibilities of using the Grid for use inside new target areas from the business domain. Thus, BREIN is dealing with all necessary functionality in a business Grid to enable enterprises to simplify their relationships complexity by using its infrastructure. To this end, BREIN will give the best support possible to enhance business and to optimize business execution whilst minimising interaction and knowledge about the underlying technical nature of the system from the individual participants.

Key technologies in BREIN development

To build this framework, BREIN will combine concepts provided by different research areas and apply them to a Grid situation. These areas include: semantic web, multi-agent and workflow technologies in order to enable interoperability, flexibility and adaptability.

Concretely, semantic Web concepts provides to Grid business i) simplicity to users since they can describe services, SLA terms... in the language and domain they know, ii) allows for interoperability among providers (semantic descriptions of resources, services, SLA terms, security) and iii) increase the automation of human tasks decreasing time and effort in the creation and maintenance of services.

On the other hand, multiagent technology allow for i) dynamic adaptation, so that, recognising and reacting to potential problems increasing reliability: ii) adaptative negotiation for defining enterprises collaboration contracts driven by enterprises objectives, iii) decision taken without human intervention.

Key concepts in BREIN development

A key concept in the approach is that of the "**bipartite** (that is two-party) **agreement**", which is the contract established between two parties, deriving from a negotiation and describing the service, its quality and the terms under which it is delivered. This model closely follows real B2B practice and does not impose any restriction on the aspect of the value chain or the pricing model of each participant. It does not require the previous establishment of a virtual organization beforehand and defining the participants in the process. Therefore, there is no central component that manages the Virtual Organization lifecycle, and each participant establishes bipartite relationships with other

participants, to govern their business interactions and the services traded between them.

Another fundamental concept in Grid is **virtualization**. This provides companies with means of provisioning for a service in any way they see fit, as long as it is compliant with the terms of the agreements they have with their customers. A provider could change their internal infrastructure and their clients will not perceive any change. This provides the freedom of managing the internal resources without any restriction and facilitates the adaptation to changing business circumstances.

Finally, **orchestration** achieves the realization of customer workflow towards business requirements, in terms of the integration of different provider's services and collaboration with different enterprises.

General Benefits Provided by BREIN

BREIN is currently working on achieving the enough dynamicity and flexibility to address the complex relationships among stakeholders in the new value chain provided by these new business models described above. Dynamicity is addressed by separating customer goals with processes execution, which means that business processes are not defined statically, but are determined at runtime. Flexibility is obtained since BREIN allows the system to be able to react to failures in execution or SLA violations. Concretely, BREIN plans to deliver the following technological innovations.

Dynamic Workflow

Workflow allows customers to connect services from providers together to deliver more complex, flexible services directly addressing their business requirements. BREIN addresses dynamic workflow by making a distinction between abstract and concrete workflow. The abstract workflow is defined by a high level language close to the human language, where the user is able to define their requirements in terms of processes goals. On the other hand, concrete workflow is executable involving actual services, SLAs, security etc, and is translated from abstract workflow by the process of evaluation. This means that the same abstract workflow may be executed at different providers every time it is executed, as the binding to the providers can be done at runtime. This gives a great deal of flexibility, and robustness is achieved through the replacement of a non-performing provider with another at runtime.

Enhanced SLA Management

The delivery of business services is typically bound by Service Level Agreements (SLAs), describing the expected functionality and potential reactions to missing the obligations. The BREIN approach is to enhance existing work in SLA by exploiting semantic descriptions of the services offered and their dependencies to achieve interoperability among providers, as well as to use concepts from the multi-agents domain enabling a faster enactment of necessary actions and decisions without necessary human intervention.

Morevoer, BREIN considers SLA service provider's management being SLA offered in line with their management policies, priorities, and business and provisioning strategies. These policies can be priority driven (based on the overall business goals/objectives of the service provider) and with that, they will influence the decisions taken by the provider.

Planning Support

As BREIN allows providers and customers to define their enteprises' goals to be achieved getting intelligent components to map the goals to a composition of available services. With that, BREIN automatically enables reaction to service failures, driven by policies or in general changes in the execution in the environments. This capacity of automatic reaction and self-management is essential to increase reliability for consumers, and this will in turn benefit providers. When outsourcing a task, a customer is relying on external companies. This situation can be very risky, and guarantees are required to ensure that the service providers will perform as expected. SLA terms assist the customer in that they encapsulate the vested interest for the provider in correctly providing the service: if they provide the service correctly, they will get paid, and if they do not, they will have to pay a penalty for example. In addition, the customer can insulate themselves from risk though having alternative strategies. This may range from different providers to perform the same abstract task, to complete alternative workflows that achieve the same goal.

Security

The BREIN vision is to support dynamic collaboration creation by allowing a user to collaborate with other on a B2B level, and with the BREIN framework triggering the necessary actions based on this. Security is considered from the first design stages, and is predicated on the SLA and the business relationships. This is because the SLA and business relationships provide a binding contractual foundation. In effect, these elements provide a root of trust for collaboration. Trust is defined from the point of view of the trusting party: it is the confidence that another party (the trustee) will behave as the trustee expects. To increase this confidence, it is helpful to give the trustee a vested interest in behaving as the trustee expects, and SLAs and business relationships provide the mechanism for this. There are payments for correct behaviour and penalties (and possibly court proceedings) for violations.

Access control is considered from a fine-grained, least privilege perspective. A user will only have access to exactly what they need to do their work, and no more. This means that there is no Unix login, but access is constrained to an individual data set or running job and the actions permitted on these items are tightly constrained as well.

BREIN LIFECICLE AND VALIDATION SCENARIOS

For the demonstration of the capabilities and functionalities that may be available using the BREIN framework, two complimentary scenarios have been defined with different (but nevertheless compatible) scopes, contexts and approaches. Both scenarios cover the formation, cooperation, interoperation and integration between different service providers that create a Virtual Organization (VO) for the purpose of addressing the goal defined by the customer. The goal of this VO is to enable customers to request the remote execution of a workflow containing several services that may be provided by different providers. However, the customer goal and its business policies may be at least different or even contradictory to the business policies of each service provider. This view of BREIN is shown in the next figure, which also includes some of the main building blocks of the framework.

In the VO normal operation, the BREIN platform and its components will be firstly involved in the discovery of the services that will be included in the overall process to achieve the VO goal, by means of the already mentioned generic workflow. The negotiation and subsequent selection make use of semantics in the terms already described of establishing a common language for the description of both the service and its SLAs. With this input, BREIN permits negotiation with several service providers and establishment of the VO by an agreement between all the stakeholders, assigning every node of the workflow to a specific service provided by a single service provider, once its capabilities and SLAs are compatible with the ones stated in the abstract workflow.

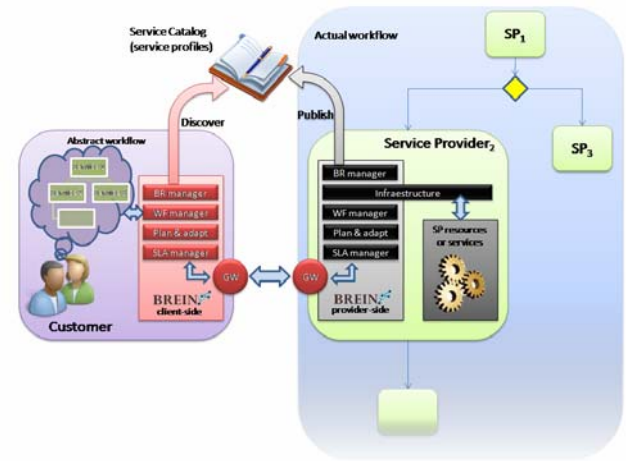


Figure. 3. shows the BREIN functionalities allocated in customer and service provider side.

If there is not any violation in the process, the workflow will be executed without any interruption. In the case of any violation, the client-side planning process will adapt the process by renegotiating and reassigning another service provider for the service that has failed or violated the agreement, trying to reach the VO goal with the minimum side-effects. This will be underpinned in BREIN by means of intelligent agents technology, which eases these processes by means of its main features: (1) autonomy as agents does not require human interaction, (2) reactivity to environment events (i.e. SLA violation), (3) pro-activeness exhibiting goal-directed behaviours (replace service who might violate some SLA with another one, trying to accomplish the overall goal) and (4) social ability to interact with other intelligent agents (negotiations within BREIN customers and providers).

Virtual Engineering Design Scenario

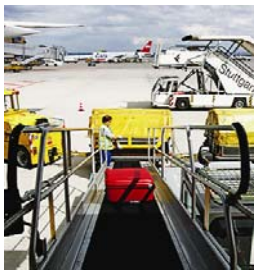
The Virtual Engineering Design scenario covers a typical Grid use case that involves several computational, simulation and visualization services for performing engineering design. These services can range from a simple computing provision to complex geometry or mesh generation for CFD codes. As described above, the customer wants to reduce time and cost, and this goal must be reconciled with the business policies of each service provider – to maximize benefit by optimizing resource usage and avoiding performance peaks, and the mechanism for this reconciliation is negotiation.

The main benefits of BREIN that are exploited by this scenario are (1) reliability, by means of the security and the proven grid reliability when some computational resource is needed, (2) auto-management in terms of automatic response to unexpected or new events by means of the intelligent agents implemented in BREIN (this also increases reliability from the customer's perspective) and (3) business orientation, thanks to the workflow and SLA negotiation support underpinned by semantic technologies.

Airport Management Scenario

The inclusion of Stuttgart Airport in a research project about Grid initially seems confusing because this scenario goes away from the classical view of Grid. However, the Airport scenario addresses resource management and provisioning aspects, which are critical to Grid service provision. The only difference is that in the Airport, resources are, luggage handling, buses, gangways, cleaning services, catering etc, rather than the traditional Grid resources of CPUs, memory and storage. The Airport is a good example of a big collaborative environment where market-based resource management techniques can equally apply to an airport or a computational cluster, and lessons can be learned from one scenario that can apply to the other. It is in this sense that the scenarios, while apparently very different, are described as complimentary.

This scenario covers the use of the airport as a virtual hub in which every service provider, by means of the different companies that operate in the airport (i.e., commercial companies or public authorities), collaborate with each other to accomplish the overall goal: to efficiently and optimally manage all the organizational and logistics processes. As in the virtual engineering scenario, the overall goal may or may not be compatible with every stakeholder individual goals (i.e., pilots and control agencies attach great importance to security issues, which is not usually compatible with the airline individual goal of reducing transfer and waiting times), and negotiation is required to manage these conflicts.



Optimal management of all the airport processes could lead to a new business opportunity: once the airport can efficiently manage, for instance, flights and planes, a new offering combining two flights almost in real time could be offered, and this is the overall goal of the Airport scenario. In the normal operation of the airport when no incidents may occur, the behaviour of the BREIN platform and its components will be to monitor the overall planning and schedule for every service resource. When events happen that could cause, for instance, a flight delay caused by an issue in a passenger bus, the BREIN platform will directly and automatically perform the correct adjustments and adaptations underpinned by intelligent agents, for rescheduling and reassignment the resources of the affected services to hopefully maintain and reach the overall goal despite the unexpected events, or to minimize the impact of the unexpected events.

CONCLUSIONS

Overall, BREIN's remit is to facilitate the participation of SMEs by simplifying the access of them to a

collaborative business Grid. BREIN's research goal is to investigate the integration of a set of different disciplines with the aim of addressing some of the major barriers preventing companies' participation in a collaborative business Grid. To address this, BREIN has a set of characteristics that can help to shorten the time for the adoption and utilization of this environment, being some key aspects carried out by BREIN:

- The incorporation of security policies in a virtualized environment;
- The freedom of evolving and adapting internal infrastructure without affecting the external offering to customers; and
- The possibility of defining the business processes in an abstract way, without defining concrete service providers or services.

The system will plan the execution of the process depending on the availability of services and the experience on previous business relationships. This abstract description gives also the freedom to the platform to replan part or all of workflow when reacting to unexpected situations.

The Semantic Web and the Multi-agents technologies are key elements of the architecture and enablers of the advanced functionality described in this paper. These technologies provide the means for a common understanding among customers and service providers about the description of the SLA and intelligent negotiations of SLAs, together with the possibility of defining process and policies in an abstract way, so that different offers from different providers can be compared in a like-for-like way. The combination of these factors increases the simplicity and reliability for users of a business Grid, and thus will promote the uptake of it for non-expert users.

BREIN GENERAL INFORMATION

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